

NRM
Misc

FACTS APPLICABLE TO THE MANUFACTURE OF
PULP AND PAPER IN THE
NORTHERN ROCKY MOUNTAIN AREA

Compiled by the Forest Products Laboratory,
Madison, Wisconsin, and reproduced by the
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Pulping Characteristics of Lodgepole Pine and Engelmann Spruce

Lodgepole Pine

Lodgepole pine is a particularly desirable species for the manufacture of sulfate (kraft) pulp. Although like other pines it is best suited for the manufacture of sulfate pulp, it also produces good-quality sulfite and groundwood pulps. The quality of lodgepole pine sulfate pulps is equal or superior to the sulfate pulps made from northern jack pine commonly used in northern sulfate mills for the manufacture of high-quality specialty papers. Compared with southern pine or Douglas-fir sulfate pulps, the lodgepole pine pulps are characterized by a higher Mullen strength and lower tearing strength and approach more closely the quality of spruce and hemlock sulfate pulps.

The yield of sulfate pulp on a weight basis is similar to that from other commonly used pulpwoods. In comparison with northern jack pine, lodgepole pine has a relatively thin bark and produces straight bolts free of large knots, so that the volume of solid wood in a cord tends to be somewhat higher. For this reason a higher yield is usually obtained from a cord of lodgepole pine compared to the cord yield from typical jack pine.

During recent years Wisconsin pulp mills have used considerable quantities of lodgepole pine from Montana. Some quantities of lodgepole pine have also been used recently by mills in the Pacific Northwest, where the wood is regarded as a highly desirable species for pulp.

It is general experience with lodgepole pine and with most other species that wood having the same range of specific gravity, size, and other general quality characteristics produces pulp of similar quality regardless of the source of the wood.

Engelmann Spruce

Engelmann spruce has been used for many years for the manufacture of sulfite and groundwood pulp by one mill in the Inland Empire. More recently some quantities have been used by mills in Wisconsin. Engelmann spruce, like other spruces, is one of the few highly preferred species for the manufacture of sulfite and groundwood pulps. The density of Engelmann spruce tends to be somewhat lower than the average for white or black spruce. The pulp yield and quality from Engelmann spruce, however, are similar to those obtained from white spruce having the same density and other wood characteristics.

Engelmann spruce also produces sulfate (kraft) pulp of excellent quality. Spruce pulps generally tend to have a slightly higher tensile strength than pine pulps and are preferred for the manufacture of certain high-grade specialties or for blending with other pulps when it is desirable.

The comparatively low density of Engelmann spruce is offset to a considerable extent by its relatively high solid volume per cord. The relatively high volume results from its thin bark, straightness, and generally high quality. As is usually the case with other species, the yield and quality of the pulp are determined by the wood characteristics, the size, straightness, density, rate of growth, and other factors. The source of the wood is not an important factor except as it may affect these wood properties.

Pulp Manufacturing Factors

Economic Sizes of Mills and Investment Costs

The smallest size of chemical pulp mill for economical operation is one with a capacity of about 100 tons per 24 hours. This minimum figure, however, would apply only to special cases or a special quality product. High-tonnage products such as kraft pulp wrapping or paperboard would have a minimum figure of around 250 tons. This is an estimate for a new mill. Some older pulp mills, especially those integrated with paper mills, may operate at a lower rate of production but usually not below 50 tons per day. The smallest economical size for a groundwood pulp mill is about 50 tons per day.

Pulp mill costs vary widely and have increased greatly in recent years. The cost for a groundwood or a semichemical pulp (without chemical recovery) mill will range from \$20,000 to \$30,000 per ton of daily capacity. The probable cost of a kraft or sulfite mill will range from \$50,000 to \$75,000 or more per ton per day.

Pulp Mill Operating Data

The amounts of water used in manufacturing pulp vary in practice from mill to mill and with the kind of pulp. Following are ranges reported in "Industrial Water for Pulp and Paper Manufacture" TAPPI monograph Series No. 1, published in 1942 by the Technical Association of the Pulp and Paper Industry, 122 East 42nd Street, New York, N.Y.:

	<u>Maximum</u>	<u>Minimum</u>	<u>Average</u>
	<u>Gallons per ton</u>		
Kraft: Unbleached	57,000	11,000	34,600
Bleached	93,000	91,600	92,300
Sulfite: Unbleached	62,000	40,000	51,000
Bleached	133,000	70,000	92,000
Groundwood	13,000	4,000	9,600

A tabulation of estimated water requirements for various wood-processing industries is attached. The figures given for water consumption include the water evaporated in drying the product and the water remaining in the finished product leaving the mill. Most of the water used for processing is returned to the stream in the mill effluent.

Some operating data for making different kinds of pulp are shown on a flow chart attached. Direct labor costs are indicated to be about 5 man-hours per ton for chemical pulps and about 3 man-hours per ton for groundwood. These are representative of present established mills. Improved design in new mills could be expected to lower the figures a little. Steam requirements range from 3500 to 7500 pounds per ton of chemical pulp. Electrical requirements are about 250 kw.-hours per ton for the chemical pulps and range from 900 to 1800 kw.-hours per ton for groundwood pulp.

Pollution of Streams by Pulp Mills

The possibility of polluting streams and waterways adjacent to pulp mills is an important matter for consideration. The following data may be helpful. A survey by the Wisconsin State Committee on Water Pollution in 1950 showed the following degrees of pollution:

Average of 4 kraft mills	53 pounds of oxygen (5-day BOD) per ton.
Average of 15 sulfite mills ..	416 " " " (5-day ") " "
Average of 3 groundwood mills.	3.3 " " " (5-day ") " "

The 5-day biochemical oxygen demand test (BOD) is a measure of the consumption of oxygen in the stream by the waste effluent. The BOD equivalent municipal sewage is 167 pounds of oxygen per 1000 persons.

The minimum amount of dissolved oxygen in a stream required for the support of fish life is about 3 parts per million for streams in the middle and eastern States and about 5 parts per million for cold water fish in the streams in the western States.

The required flow in a stream receiving the effluent from a 100-ton sulfite mill without spent liquor recovery in Wisconsin was estimated by the Wisconsin State Sanitary Engineer's office to be:

1200 cubic feet per second at 15° C.
1800 cubic feet per second at 20° C.
2600 cubic feet per second at 25° C.

The required flows for a kraft mill or sulfite mills with spent liquor recovery could be considered to be about 1/7 of those for a sulfite mill on the basis of the relative differences in the BOD values of the respective effluents.

ESTIMATED WATER REQUIREMENTS FOR WOOD PROCESSING INDUSTRIES

Product	Water requirements							
	: Daily : : produc- : tion :	: Daily : : wood con- : sumption :	For processing					
	: Tons	: Cu.ft.	: Gal. per : ton ² :	: Gal. per : day :	: Cu. Ft. : per day :	: Gal. per : ton :	: Gal. per : day :	: Cu.Ft. : per day :
Sulfite pulp, unbleached:	100	: 16,700	: 50,000	: 5,000,000	: 670,000:	4	: 400	: 55
Sulfite pulp, bleached	: 100	: 18,000	: 95,000	: 9,500,000	: 1,270,000:	(4)	: (4)	: (4)
Kraft pulp, unbleached	: 100	: 16,700	: 35,000	: 3,500,000	: 470,000:	4	: 400	: 55
Sulfate pulp, bleached	: 100	: 18,000	: 92,000	: 9,200,000	: 1,230,000:	(4)	: (4)	: (4)
Groundwood pulp	: 50	: 4,100	: 10,000	: 500,000	: 67,000:	314	: 15,700	: 2,100
Hardboard, wet form	: 20	: 1,800	: 2,500	: 50,000	: 6,700:	235	: 4,700	: 630
(Batch process)	:	:	:	:	:	:	:	:
Hardboard, wet form	: 30	: 2,700	: 10,000	: 300,000	: 40,000:	235	: 7,050	: 950
(continuous process)	:	:	:	:	:	:	:	:
Hardboard, dry form	:	Minor:water requirements; mainly steam for presses						
Insulation board	: 175	: 16,000	: 8,000	: 1,400,000	: 190,000:	235	: 41,125	: 5,500
Alcohol (process water)	: 11,000:	: 18,000	: 5-2,250	: 500,000	: 65,000:	(4)	: (4)	: (4)
Cooling water at 60°F	: gal. :	:	: 8,000	: 1,750,000	: 230,000:	:	:	:
Molasses (process water)	: 200	: 18,000	: 2,000	: 400,000	: 53,500:	(4)	: (4)	: (4)
Cooling water at 60°F	:	:	: 11,000	: 2,200,000	: 293,000:	:	:	:
Yeast (process water)	: 45	: 18,000	: 14,000	: 730,000	: 97,500:	(4)	: (4)	: (4)
Cooling water at 60°F	:	:	: 50,000	: 22,500,000	: 3,000,000:	:	:	:
Lumber (sawmill)	: 1 gallon per board foot of production	:	:	:	:	:	:	:

¹ Wood estimated at 24 pounds per cubic foot moisture-free weight, green volume.

² Per ton of product unless otherwise noted.

³ Water in product or otherwise lost; estimate based on use of green wood.

⁴ Slight gain if green wood is used.

⁵ Per ton moisture-free wood used.

Forest Products Laboratory
Madison, Wisconsin
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Typical Yields Obtained in Pulping Engelmann Spruce and Lodgepole Pine

Item		: Engelmann : : spruce :	Lodgepole : pine
Density of wood (moisture-free weight/green volume)	lb.:	20	24
Weight of moisture-free wood in 1 cord of rough wood	lb.:	1950	2200
<u>Sulfate pulping</u>			
Kraft-type pulp:			
Yield unbleached pulp per 100 lb. wood ¹ ...	lb.:	46-50	46-50
Yield unbleached pulp per cord ²	lb.:	940-1020	1050-1150
Bleachable type:			
Yield unbleached pulp per 100 lb. wood ¹ ...	lb.:	44	44
Yield unbleached pulp per cord ²	lb.:	900	1010
Yield bleached pulp per 100 lb. wood ¹	lb.:	42	42
Yield bleached pulp per cord ²	lb.:	855	970
<u>Sulfite pulping:</u>			
Strong type:			
Yield unbleached pulp per 100 lb. wood ¹ ...	lb.:	48-50	46-48
Yield unbleached pulp per cord ²	lb.:	980-1020	1050-1080
Bleachable type:			
Yield unbleached pulp per 100 lb. wood ¹ ...	lb.:	48	46
Yield unbleached pulp per cord ²	lb.:	980	1050
Yield bleached pulp per 100 lb. wood ¹	lb.:	45	43
Yield bleached pulp per cord ²	lb.:	920	990
<u>Groundwood pulping</u>			
Yield pulp per 100 lb. wood ¹	lb.:	95	95
Yield pulp per cord ³	lb.:	1970	2220

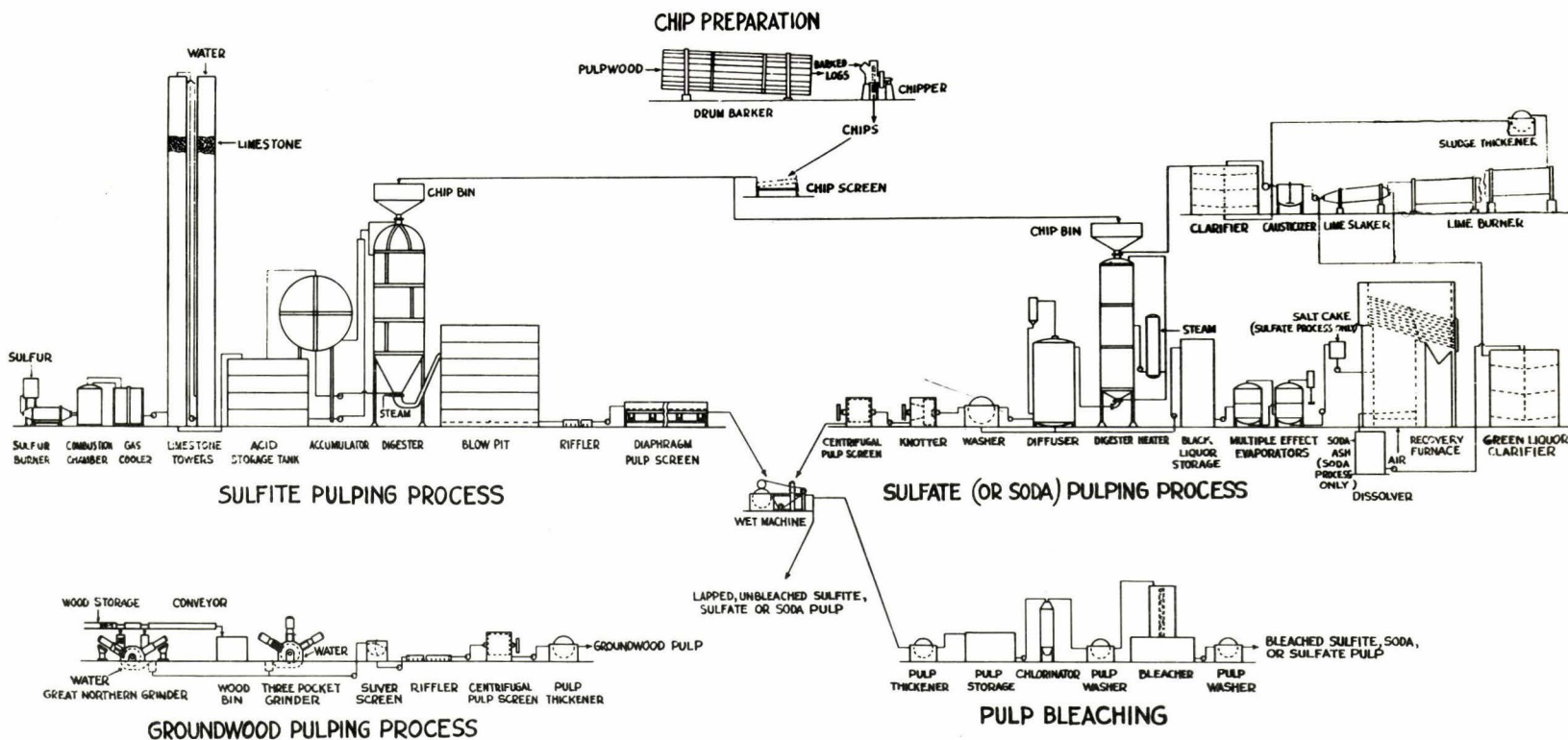
¹Moisture-free basis.

²Air-dry pulp. Total of losses of wood in barking, sawing and chipping and of fiber in white water amounting to about 6 percent is included in this estimate.

³Air-dry pulp equivalent. Total of losses of wood in barking and sawing and of fiber in white water of about 4.5 percent is included in this estimate.

MANUFACTURE OF WOOD PULP

FLOW SHEETS OF THE SULFITE, SULFATE (AND SODA), AND GROUNDWOOD PULPING PROCESSES



REQUIREMENTS PER TON OF AIR-DRY PULP

SULFITE	
WOOD	1.7 - 2.2 CORDS
SULFUR	200 - 300 POUNDS
LIMESTONE	200 - 370 POUNDS
STEAM	5000 - 7500 POUNDS
ELECTRICITY	250 K.W.-HOURS
DIRECT LABOR	4.9 MAN-HOURS

SODA	
WOOD	1.8 - 2.6 CORDS
NEW LIME	500 POUNDS
SODA ASH	250 - 500 POUNDS
STEAM	4000 - 6000 POUNDS
ELECTRICITY	250 K.W.-HOURS
DIRECT LABOR	5 MAN-HOURS

SULFATE	
WOOD	1.7 - 2.4 CORDS
NEW LIME	325 POUNDS
SALT CAKE	200 - 300 POUNDS
STEAM	2500 - 5000 POUNDS
ELECTRICITY	250 K.W.-HOURS
DIRECT LABOR	5 MAN-HOURS

GROUNDWOOD	
WOOD	0.9 - 1.3 CORDS
POWER	900 - 1800 K.W.-HOURS
WATER	35,000 - 60,000 GALLONS
DIRECT LABOR	2.5 - 3 MAN-HOURS

Summary of Pulp Manufacturing Factors

Minimum economic size for pulp mills:

Chemical pulp 100 tons to 200 tons per 24 hours, depending
upon product
Groundwood and semichemical ... 50 tons per 24 hours.

Pulp mill investment costs, including buildings:

Groundwood and semichemical
(without recovery) \$20,000 to \$30,000 per ton of daily capacity.
Chemical pulp \$50,000 to \$75,000 or more per ton per day.

Pulp mill operating data:

Average water requirements:

Kraft, unbleached 35,000 gallons per ton
Kraft, bleached 92,000 gallons per ton
Sulfite, unbleached 50,000 gallons per ton
Sulfite, bleached 95,000 gallons per ton
Groundwood 10,000 gallons per ton

Steam for chemical pulping:

Kraft 2500-5000 pounds per ton.
Sulfite 3500-7500 pounds per ton.

Electric power:

Chemical pulping 250 kw.-hours per ton.
Groundwood pulping 900-1800 kw.-hours per ton.

Labor (direct):

Chemical pulping 5 man-hours per ton.
Groundwood pulping 3 man-hours per ton.

Wood requirements:

Chemical pulping 1.7-2.4 cords per ton.
Groundwood pulping 0.9-1.3 cords per ton.

Pollution of streams by pulp mills:

Kraft pulping About 55 pounds of oxygen (5-day BOD) per ton
Sulfite pulping About 415 pounds of oxygen " " " " *
Groundwood pulping ... About 3 pounds of oxygen " " " "
Municipal sewage About 167 pounds of oxygen " " " "

*Without liquor recovery

Minimum stream flows required to maintain necessary dissolved oxygen:

For 100-ton sulfite mill without liquor recovery:

1200 cubic feet per second at 15° C.

1800 cubic feet per second at 20° C.

2600 cubic feet per second at 25° C.

For kraft mill: About 1/7 that of a sulfite mill without
liquor recovery.

In most instances stream flows well above these minimum values
should be available.

Average yields of wood pulp for various species by process, by weight, and by volume
and
average number of unbarbed cords required to make one ton of pulp

(The figures given are general averages and cannot be expected to apply accurately to individual cases)

Species	Yield of oven-dry screened pulp ²										Wood per ton of pulp ²				
	Density:														
	oven-dry:	Dry:	Sulfite ⁴	Sulfate	Soda ⁴	Mechanical									
	weight:	wood:													
	per	per	Per 100:	Per	Per 100:	Per	Per 100:	Per	Per 100:	Per	Per 100:	Per	Sul-	Sul-	Soda:
green	cord ¹ :	pounds:	cord ⁶ :	pounds:	cord ⁶ :	pounds:	cord ⁶ :	pounds:	cord ⁶ :	pounds:	cord ⁸ :	fite:	fate:		ical
volume:	dry:	wood ⁵ :	dry:	wood ⁵ :	dry:	wood ⁵ :	dry:	wood ⁵ :	dry:	wood ⁷ :					
		wood ⁵ :		wood ⁵ :		wood ⁵ :		wood ⁵ :		wood ⁷ :					
	Lb./	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Cords:	Cords:	Cords:	Cords
	cu. ft.:														
Spruce															
White.....	24	: 1990:	48	: 900:	48	: 900:	43	: 805:	95	: 1805:	2.20:	2.20:	2.50:	1.10	
Sitka.....	24	: 1990:	49	: 920:	48	: 900:	42	: 785:	95	: 1805:	2.15:	2.20:	2.55:	1.10	
Hemlock															
Eastern.....	24	: 1990:	44	: 825:	45	: 845:	42	: 785:	95	: 1805:	2.40:	2.35:	2.55:	1.10	
Western.....	24	: 1990:	46	: 860:	47	: 880:	--	: --:	95	: 1805:	2.35:	2.25:	--:	1.10	
Tamarack.....	31	: 2570:	42	: 1015:	45	: 1090:	35	: 845:	95	: 2335:	1.95:	1.85:	2.35:	.85	
Pine															
Southern ²	32	: 2660:	48	: 1085:	48	: 1200:	40	: 1000:	95	: 2185:	1.85:	1.65:	2.00:	.90	
Sand.....	29	: 2410:	--	: --:	47	: 1065:	42	: 950:	95	: 2185:	--:	1.90:	2.10:	.90	
Western															
White.....	23	: 1910:	46	: 825:	49	: 880:	42	: 755:	95	: 1730:	2.40:	2.25:	2.65:	1.15	
Ponderosa.....	23	: 1910:	--	: --:	48	: 860:	41	: 735:	95	: 1730:	--:	2.30:	2.70:	1.15	
Monterey.....	25	: 2070:	47	: 915:	47	: 915:	41	: 800:	95	: 1880:	2.20:	2.20:	2.50:	1.05	
Northern															
White.....	20	: 1660:	--	: --:	47	: 735:	42	: 655:	95	: 1505:	--:	2.70:	3.05:	1.35	
Jack.....	24	: 1990:	46	: 860:	47	: 880:	42	: 785:	95	: 1805:	2.35:	2.25:	2.55:	1.10	
Fir															
Balsam	21	: 1740:	48	: 785:	48	: 785:	42	: 690:	95	: 1580:	2.55:	2.55:	2.90:	1.25	
Lowland white....	24	: 1990:	49	: 920:	48	: 900:	35	: 655:	95	: 1805:	2.15:	2.20:	3.05:	1.10	
Silver.....	24	: 1990:	49	: 920:	50	: 935:	42	: 785:	95	: 1805:	2.15:	2.15:	2.55:	1.10	
Douglas fir.....	29	: 2410:	48	: 1085:	48	: 1085:	40	: 905:	95	: 2185:	1.85:	1.85:	2.20:	.90	
Poplar															
Aspen and balsam..	21	: 1740:	49	: 805:	50	: 820:	47	: 770:	95	: 1580:	2.50:	2.45:	2.60:	1.25	
Yellow.....	24	: 1990:	47	: 880:	47	: 880:	45	: 845:	95	: 1805:	2.25:	2.25:	2.35:	1.10	
Cottonwood															
Eastern and swamp:	22	: 1830:	47	: 810:	47	: 810:	47	: 810:	95	: 1655:	2.45:	2.45:	2.45:	1.20	
Beech.....	34	: 2820:	--	: --:	--	: --:	46	: 1220:	--	: --:	--:	--:	1.65:	--	
Birch															
Yellow and paper..	34	: 2820:	45	: 1195:	46	: 1220:	42	: 1115:	--	: --:	1.65:	1.65:	1.80:	--	
Maple															
Hard (sugar).....	35	: 2900:	44	: 1200:	43	: 1175:	42	: 1150:	--	: --:	1.65:	1.70:	1.75:	--	
Soft (red).....	30	: 2490:	44	: 1030:	43	: 1005:	42	: 985:	--	: --:	1.95:	2.00:	2.05:	--	
Gum															
Tupelo.....	28	: 2320:	48	: 1050:	48	: 1050:	42	: 920:	95	: 2110:	1.90:	1.90:	2.15:	.95	
Black.....	28	: 2320:	48	: 1050:	48	: 1050:	43	: 940:	95	: 2110:	1.90:	1.90:	2.15:	.95	
Red.....	28	: 2320:	46	: 1005:	48	: 1050:	45	: 985:	95	: 2110:	2.00:	1.90:	2.05:	.95	
Chestnut.....	25	: 2070:	42	: 820:	--	: --:	38	: 740:	--	: --:	2.45:	--:	2.70:	--	
Blackjack oak.....	40	: 3320:	41	: 1280:	45	: 1410:	42	: 1310:	--	: --:	1.55:	1.40:	1.55:	--	
Cypress.....	27	: 2240:	46	: 970:	48	: 1010:	40	: 845:	--	: --:	2.05:	2.00:	2.35:	--	

¹The values in this column are expressed to the nearest 10 pounds. They are based on an average of 65 percent of solid wood in a stacked volume of logs with the bark on, i.e., 83 cubic feet per cord of 4-foot logs stacked 8 feet long and 4 feet high. This factor may vary with length, diameter, crook, knottiness, bark thickness, size of pile, and closeness of piling from as low as 75 to as high as 90 or more cubic feet per standard cord. The approximate solid-volume of a cord of barked wood is 1.15 times that with the bark on.

²Screenings are frequently refined and returned to the pulp system or converted into lower-grade products and therefore do not constitute a total loss.

³In estimating the volumes of wood given in these columns allowance has been made for certain losses occurring in commercial practice (see footnotes 6 and 8) and the results expressed to the nearest 1/20 cord. Mill production is usually based on air-dry pulp having an assumed moisture content of 10 percent. Therefore to convert to cords of wood per ton of air-dry pulp multiply these values by 0.9.

⁴Bleachable pulp.

TECHNICAL NOTE NUMBER 191

FOREST PRODUCTS LABORATORY

UNITED STATES FOREST SERVICE

MADISON, WISCONSIN

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AVERAGE YIELDS OF WOOD PULP FROM VARIOUS SPECIES OF WOOD

The Forest Products Laboratory is frequently called upon for information regarding the yields of wood pulp from various species. Pulp yields vary considerably not only between species but within species because of variations in properties caused by growth conditions. Pulp yields also vary with the pulping process employed. During the course of many years of experimentation at the Laboratory, however, data have been obtained that make it possible to report approximate average figures for a number of species.

The table of yields presented here does not contain all species worked on at the Laboratory nor the results of the many variations of the standard pulping processes that have been tried out. Instead the table is confined to the four principal pulping processes and to the major pulpwood species and a number of abundant, potentially valuable though little-used species.

The yields in the table are based on the average volume of wood in racked cords and therefore differ slightly from those based on large piles of wood and varying mensuration practices such as are sometimes reported by mills. On the basis of pulpwood and wood pulp statistics, the U. S. Tariff Commission reported in 1938 the average cords of wood required to make one ton of air-dry pulp for the various processes as follows: Sulphite pulp 1.965 cords, sulphate pulp 1.786 cords, soda pulp 1.813 cords, and groundwood pulp 0.973 cord. If the corresponding values in the last four columns of the table are reduced to the basis of one ton of air-dry pulp, slightly higher figures than the foregoing averages are obtained.

WOOD PULP MILLS IN MICHIGAN

	<u>City</u>
Detroit Sulphite Pulp and Paper Co.	Detroit (2)
American Box-Board Co., American Pulp and Paper Division	Filer City (4)
Escanaba Paper Co.	Groos (1)
Manistique Pulp and Paper Co.	Manistique (1)
Marinette Paper Co.	Menominee (1)
Munising Paper Co.	Munising (2)
Central Paper Co.	Muskegon (3)
National Container Corporation of Michigan	Ontonagon (3)
Otsego Falls Paper Mills, Inc.	Otsego (4)
Watervliet Paper Co.	Watervliet (4)

WOOD PULP MILLS IN MINNESOTA

Northwest Paper Co.	Brainerd (1)
Northwest Paper Co.	Cloquet (2) (3)
Wood Conversion Co.	Cloquet (4)
Blandin Paper Co.	Grand Rapids (1)
Minnesota & Ontario Paper Co.	International Falls (1) (2) (3)
St. Regis Paper Co.	Little Falls (1)
St. Regis Paper Co. ...	Sartell (1)

- (1) Groundwood pulp
- (2) Sulfite pulp
- (3) Sulfate or kraft pulp
- (4) Semichemical pulp

(List taken from Lockwood's Directory of the Paper and Allied Trades)
1951

LIST OF WOOD PULP MILLS IN WISCONSIN

Legend: (1) Groundwood or mechanical pulp.
(2) Sulfite pulp.
(3) Sulfate or kraft pulp.
(4) Semichemical pulp.

APPLETON	Consolidated Water Power & Paper Co. (2)
BROKAW	Wausau Paper Mills Co. (2)
COMBINED LOCKS	Combined Locks Paper Co. (1)
CORNELL	Cornell Wood Products Co. (1) (4)
EAU CLAIRE	Sterling Pulp and Paper Co. (1) (2)
GREEN BAY	Fort Howard Paper Co. (1) Hoberg Paper Mills, Inc. (1) (2) Northern Paper Mills (1) (2) Green Bay Paper and Pulp Co. (4)
KAUKAUNA	Thilmany Pulp and Paper Co. (3)
KIMBERLY	Kimberly-Clark Corporation (1) (2)
LADYSMITH	Peavey Paper Mills, Inc. (1)
LITTLE RAPIDS	Little Rapids Pulp Co. (1)
MARINETTE	Marinette Paper Co. (2)
MOSINEE	Mosinee Paper Mills Co. (3)
NEKOOSA	Nekoosa-Edwards Paper Co., Inc. (3)
NIAGARA	Kimberly-Clark Corporation (1) (2)
OCONTO FALLS	Falls Paper and Power Co. (1) (2)
PARK FALLS	Flambeau Paper Co. (1) (2)
PESHTIGO	Badger Paper Mills, Inc. (2)
PORT EDWARDS	Nekoosa-Edwards Paper Co., Inc. (2)
RHINELANDER	Rhineland Paper Co. (2)
ROTHSCHILD	Marathon Corporation (2)
STEVENS POINT	Consolidated Water Power and Paper Co. (1) Stevens Point Pulp and Paper Co. (3)
TOMAHAWK	International Container Corporation of Wis. (3) (4) Tomahawk Pulp Company (1)
WISCONSIN RAPIDS	Consolidated Water Power and Paper Co. (1) (2) (4)

--Taken from "Posts Paper Mill Directory,"
1951